

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

NOTIFICATION OF TRANSMITTAL OF
THE INTERNATIONAL SEARCH REPORT AND
THE WRITTEN OPINION OF THE INTERNATIONAL
SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

To:

MURGITROYD & COMPANY
Scotland House
165-169 Scotland Street
Glasgow
G3 7PL
GRANDE BRETAGNE

Date of mailing
(day/month/year)

04/08/2008

Applicant's or agent's file reference

P101097.WO.1

FOR FURTHER ACTION

See paragraphs 1 and 4 below

International application No.

PCT/GB2008/050210

International filing date
(day/month/year)

21/03/2008

Applicant

PURSUIT DYNAMICS PLC

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the International Application (see Rule 46):

When? The time limit for filing such amendments is normally two months from the date of transmittal of the International Search Report.

Where? Directly to the International Bureau of WIPO, 34 chemin des Colombettes
1211 Geneva 20, Switzerland. Facsimile No.: (41-22) 338.82.70

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

- ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

- ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. Reminders

Shortly after the expiration of **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90bis.1 and 90bis.3, respectively, before the completion of the technical preparations for international publication.

The applicant may submit comments on an informal basis on the written opinion of the International Searching Authority to the International Bureau. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established. These comments would also be made available to the public but not before the expiration of 30 months from the priority date.

Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the International Searching Authority



European Patent Office, P.B. 5818 Patentlaan 2
NL-2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl.
Fax: (+31-70) 340-3016

Authorized officer

Véronique Cornudet

NOTES TO FORM PCT/ISA/220

These Notes are intended to give the basic instructions concerning the filing of amendments under article 19. The Notes are based on the requirements of the Patent Cooperation Treaty, the Regulations and the Administrative Instructions under that Treaty. In case of discrepancy between these Notes and those requirements, the latter are applicable. For more detailed information, see also the *PCT Applicant's Guide*, a publication of WIPO.

In these Notes, 'Article', 'Rule', and 'Section' refer to the provisions of the PCT, the PCT Regulations and the PCT Administrative Instructions, respectively.

INSTRUCTIONS CONCERNING AMENDMENTS UNDER ARTICLE 19

The applicant has, after having received the international search report and the written opinion of the International Searching Authority, one opportunity to amend the claims of the international application. It should however be emphasized that, since all parts of the international application (claims, description and drawings) may be amended during the international preliminary examination procedure, there is usually no need to file amendments of the claims under Article 19 except where, e.g. the applicant wants the latter to be published for the purposes of provisional protection or has another reason for amending the claims before international publication. Furthermore, it should be emphasized that provisional protection is available in some States only (see *PCT Applicant's Guide*, Volume I/A, Annexes B1 and B2).

The attention of the applicant is drawn to the fact that amendments to the claims under Article 19 are not allowed where the International Searching Authority has declared, under Article 17(2), that no international search report would be established (see *PCT Applicant's Guide*, Volume I/A, paragraph 296).

What parts of the international application may be amended?

Under Article 19, only the claims may be amended.

During the international phase, the claims may also be amended (or further amended) under Article 34 before the International Preliminary Examining Authority. The description and drawings may only be amended under Article 34 before the International Examining Authority.

Upon entry into the national phase, all parts of the international application may be amended under Article 28 or, where applicable, Article 41.

When?

Within 2 months from the date of transmittal of the international search report or 16 months from the priority date, whichever time limit expires later. It should be noted, however, that the amendments will be considered as having been received on time if they are received by the International Bureau after the expiration of the applicable time limit but before the completion of the technical preparations for international publication (Rule 46.1).

Where not to file the amendments?

The amendments may only be filed with the International Bureau and not with the receiving Office or the International Searching Authority (Rule 46.2).

Where a demand for international preliminary examination has been/is filed, see below.

How?

Either by cancelling one or more entire claims, by adding one or more new claims or by amending the text of one or more of the claims as filed.

A replacement sheet must be submitted for each sheet of the claims which, on account of an amendment or amendments, differs from the sheet originally filed.

All the claims appearing on a replacement sheet must be numbered in Arabic numerals. Where a claim is cancelled, no renumbering of the other claims is required. In all cases where claims are renumbered, they must be renumbered consecutively (Section 205(b)).

The amendments must be made in the language in which the international application is to be published.

What documents must/may accompany the amendments?

Letter (Section 205(b)):

The amendments must be submitted with a letter.

The letter will not be published with the international application and the amended claims. It should not be confused with the "Statement under Article 19(1)" (see below, under "Statement under Article 19(1)").

The letter must be in English or French, at the choice of the applicant. However, if the language of the international application is English, the letter must be in English; if the language of the international application is French, the letter must be in French.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference P101097.WO.1	FOR FURTHER ACTION see Form PCT/ISA/220 as well as, where applicable, item 5 below.	
International application No. PCT/GB2008/050210	International filing date (day-month-year) 21/03/2008	(Earliest) Priority Date (day-month-year) 02/05/2007
Applicant PURSUIT DYNAMICS PLC		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 3 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of:

- ☒ the international application in the language in which it was filed
☐ a translation of the international application into _____, which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6**bis**(a)).

c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (See Box No. II)

3. ☐ **Unity of invention is lacking** (see Box No. III)

4. With regard to the **title**,

- ☐ the text is approved as submitted by the applicant
☒ the text has been established by this Authority to read as follows:

LIQUEFACTION OF STARCH-BASED BIOMASS

5. With regard to the **abstract**,

- ☒ the text is approved as submitted by the applicant
☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority

6. With regard to the **drawings**,

- a. the figure of the **drawings** to be published with the abstract is Figure No. 1
☒ as suggested by the applicant
☐ as selected by this Authority, because the applicant failed to suggest a figure
☐ as selected by this Authority, because this figure better characterizes the invention
 b. ☐ none of the figures is to be published with the abstract

INTERNATIONAL SEARCH REPORT

International application No

PCT/GB2008/050210

A. CLASSIFICATION OF SUBJECT MATTER

INV. C12P19/14 C13K1/06 B01F5/04 C12M1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols):

C12P C13K C12M B01F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, EMBASE, BIOSIS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>GB 1 028 211 A (ESCHER WYSS GMBH) 4 May 1966 (1966-05-04)</p> <p>page 1, lines 8-73 pages 3-5; examples 1-3 figures 1-4 -& GB 995 660 A (ESCHER WYSS GMBH) 23 June 1965 (1965-06-23) page 2, line 9 - page 4, line 94 figures 1-8</p> <p>-----</p>	<p>1, 2, 4, 5, 7, 9-12, 14-16, 19, 21, 23, 25, 26, 30-32, 34</p>

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- *8* document member of the same patent family

Date of the actual completion of the international search

24 July 2008

Date of mailing of the international search report

04/08/2008

Name and mailing address of the ISA:

European Patent Office, P.O. 5818 Patentaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040. Tx 31 651 epo nl
Fax: (+31-70) 340-3016

Authorized officer

Schröder, Gunnar

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2008/050210

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
GB 1028211	A	04-05-1966	CH 399372 A	15-09-1965
			CH 440176 A	15-07-1967
			DE 1567367 A1	02-07-1970
			DE 1172620 B	18-06-1964
			DE 1190890 B	08-04-1965
			DE 1189030 B	11-03-1965
			GB 995660 A	23-06-1965
			NL 283530 A	
			NL 7313559 A	25-01-1974
			US 3219483 A	23-11-1965
			US 3308037 A	07-03-1967
GB 995660	A	23-06-1965	CH 399372 A	15-09-1965
			CH 440176 A	15-07-1967
			DE 1567367 A1	02-07-1970
			DE 1172620 B	18-06-1964
			DE 1190890 B	08-04-1965
			DE 1189030 B	11-03-1965
			GB 1028211 A	04-05-1966
			NL 283530 A	
			NL 7313559 A	25-01-1974
			US 3219483 A	23-11-1965
			US 3308037 A	07-03-1967

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

PCT

see form PCT/ISA/220

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY (PCT Rule 43bis.1)

Date of mailing
(day month year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.	International filing date (day month year)	Priority date (day month year)
PCT/GB2008/050210	21.03.2008	02.05.2007

International Patent Classification (IPC) or both national classification and IPC
INV. C12P19/14 C13K1/06 B01F5/04 C12M1/00

Applicant
PURSUIT DYNAMICS PLC

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. FURTHER ACTION

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA:



European Patent Office - Gitschiner Str. 103
D-10958 Berlin
Tel. +49 30 25901-0
Fax: +49 30 25901-340

Date of completion of
this opinion

see form
PCT/ISA/210

Authorized Officer

Schröder, Gunnar

Telephone No. +49 30 25901-326



WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/GB2008/050210

Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:
 - ☐ the international application in the language in which it was filed
 - ☐ a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).
2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))
3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application and necessary to the claimed invention, this opinion has been established on the basis of:
 - a. type of material:
 - ☐ a sequence listing
 - ☐ table(s) related to the sequence listing
 - b. format of material:
 - ☐ on paper
 - ☐ in electronic form
 - c. time of filing/furnishing:
 - ☐ contained in the international application as filed.
 - ☐ filed together with the international application in electronic form.
 - ☐ furnished subsequently to this Authority for the purposes of search.
4. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT GB2008/050210

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	<u>3.6.8.13.17.18.20.22.24.27-29.33.35</u>
	No: Claims	<u>1.2.4.5.7.9-12.14-16.19.21.23.25.26.30-32.34</u>
Inventive step (IS)	Yes: Claims	<u>8.13.24.28.29.35</u>
	No: Claims	<u>1-7.9-12.14-23.25-27.30-34</u>
Industrial applicability (IA)	Yes: Claims	<u>1-35</u>
	No: Claims	

2. Citations and explanations

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability;
citations and explanations supporting such statement

Reference is made to the following documents:

D1: GB-A-1 028 211 (ESCHER WYSS GMBH) 4 May 1966 (1966-05-04)

D2: GB-A-995 660 (ESCHER WYSS GMBH) 23 June 1965 (1965-06-23)

1. The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1, 7 and 9 is not new in the sense of Article 33(2) PCT.

The document D1 discloses (the references in parentheses applying to this document):

A process for the treatment of a starch-based feedstock (page 1, lines 8-20), comprising:

- A) mixing together starch-based feedstock and working fluid (water) to form a slurry;
- B) hydrating the starch-based feedstock with the working fluid;
- C) adding a liquefaction enzyme (alpha-amylase) to the slurry (page 3, lines 16-24);
- D) pumping the slurry into a passage of a starch activation device (vessel 4; page 3, lines 24-25); and
- E) injecting a high velocity transport fluid (pressurized steam) into the slurry, thereby further hydrating the starch-based feedstock and activating the starch content of the slurry (page 3, lines 25-29).

The document D2 is cited in D1 and is said to disclose the apparatus suitable for carrying out the above step E) of the process (see D1, page 1, lines 23-28).

Document D2 discloses:

An apparatus for injecting a high velocity transport fluid into a starch slurry through a nozzle communicating with the passage of a starch activation device (D2, page 2, lines 9-50 and claims 1-3).

Therefore, the subject-matter of claim 1 is not new.

PATENT SPECIFICATION

1,028,211

DRAWINGS ATTACHED.

1,028,211



Date of Application and filing Complete Specification:
Oct. 22, 1962. No. 39969/62.

Application made in Germany (No. E21843 IVa/89k) on
Oct. 21, 1961.

Application made in Germany (No. E23149 IVa/89k) on
July 5, 1962.

Complete Specification Published: May 4, 1966.

© Crown Copyright 1966.

Index at Acceptance:—C3 U1A; B1 F4HX; B1 X16; C2 C3A18.

Int. Cl.:—C 08 b /B 01 j, C 07 d.

COMPLETE SPECIFICATION.

Improvements in or relating to The Manufacture of Starch Decomposition Products.

We, ESCHER WYSS G.m.b.H., a German Body Corporate, of Ravensburg, Württemberg, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

This invention relates to a process and installation for the continuous manufacture of starch decomposition products, in which process and installation a chemically and/or biologically active substance is added to a starch suspension, the mixture being passed continuously through a reaction vessel with temporary acceleration of the flow followed by direct mixing with steam, the added substance becoming active during and directly after the steam passage in a field of action of high imposed stress by impacting and/or shearing forces. We have claimed this process as claim 1 of United Kingdom Patent Application No. 49829/65 (Serial 1,028,212).

In United Kingdom Patent Specification No. 995,660 we have disclosed and claimed apparatus which forms a suitable reaction vessel for use in effecting the step of temporarily accelerating the flow followed by direct mixing with steam.

Our objects in the present invention are to improve and develop the above process, particularly for producing *d*-glucose or dextrin, by means of additional steps which adjust the required chemical or physical properties of the product, and to provide installations suitable for use in performing the improved process.

The present invention consists in a continuous process for the manufacture of starch decomposition products, particularly *d*-glucose or dextrin, which process com-

prises the steps of adding a chemically and/or biologically active substance to a starch suspension, passing the mixture continuously through a reaction vessel with temporary acceleration of the flow followed by direct mixing with steam, the added substance becoming active during and directly after the steam passage in a field of action of high imposed stress by impacting and/or shearing forces, and conducting the primarily liquified starch paste thus obtained through at least one additional reaction vessel for the purpose of continuing the degradation reaction and adjusting required chemical or physical properties, the free cross-sectional area of the additional reaction vessel being larger than that of the pipe conduits before and after the first-mentioned reaction vessel.

The invention also consists in an installation for effecting the process according to the preceding paragraph, comprising a first reaction vessel for the continuous primary liquefaction of starch as a result of the action of a chemically and/or biologically active substance, means for inactivating or destroying this active substance, and a second reaction vessel for continuation of the degradation reaction, said second reaction vessel being connected between said first reaction vessel and said means and having a free cross-sectional area which is larger than the pipe conduits before and after the said first reaction vessel.

The performance of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:—

Figure 1 shows an installation in accordance with the invention for the production of *d*-glucose;

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purpose of complete inactivation of the active substances. Thereafter, the product is discharged through a throttle member 21 and an expansion chamber 22. In the same way as the thermal enzyme inactivation, it is also possible by means of the device 18 to carry out a chemical enzyme inactivation by feeding in a substance which acts as a poison to the enzyme.

The following two examples are intended to provide further details of the process of this invention as performed using the installation of Figure 1. All percentages are percentages by weight unless otherwise stated:

EXAMPLE 1

By mixing 100 kg. of maize starch of normal commercial moisture content with 120 litres of water, a 40% starch suspension is prepared in the tank 1 and 0.3 to 0.5% of α -amylase of industrial purity, based on the air-dry starch batch is added thereto and the suspension is adjusted to the optimum reaction conditions by adding chemicals. The product is continuously conveyed through the reaction vessel 4 and, by feeding in steam at a pressure of 5 to 10 atm. gauge, and by imposing stress by impacting and/or shearing forces is heated to 95°C., gelatinised and primarily liquefied. For continuing the degradation reaction, the starch solution is pumped through one of the reaction vessels 6¹, 6², and after reaching a controlled degree of degradation, passes through the reaction vessel 10, which is of similar construction to the reaction vessel 4. The intermediate product is diluted in vessel 10 to 30 to 35% solid content by feeding in a solution or dispersion of β -amylase or α -glucodiase in cold water from the tank 12, and is thus cooled to 60 to 70°C. and mixed with this second specifically active enzyme. The product is thereafter advantageously conveyed into the device 17 for intensively mixing the enzyme with the primarily produced dextrin solution and subsequently conducted into the vessel 16 for continuing the degradation reaction. Finally, it passes through the device 18, the inactivation zone 20 and the expansion chamber 22. The sugar solution thus obtained is purified, concentrated and either worked up to a syrup with a high maltose or glucose content or transferred into an arrangement (not shown) for the crystallisation of the dissolved sugar.

EXAMPLE 2

The production of d-glucose is effected substantially by the same process as that indicated in Example 1. Before admixing a temperature-sensitive enzyme, however, the product initially liquefied by thermophilic α -amylase is cooled in the cooler 15 to such a degree that the addition of the carbohydrase intended for the subsequent

saccharification can be effected with small quantity of water sufficient for the complete mixing and the final saccharification can be carried out in a temperature range from 40 to 60°C.

The installation according to Figure 2 is intended for the production of dextrin. It comprises in part the same devices and apparatus as the arrangement shown in Figure 1, and consequently these are provided with the same reference numerals.

The starch suspension prepared in the tank 1 and mixed with amylase is again conveyed by means of the proportioning pump 3 into the reaction vessel 4, in which the gelatinisation and primary liquefaction of the starch is effected by mixing with steam supplied from the pipe 5. In this case, instead of the vessels 6¹, 6² for continuing the degradation reaction, mainly cylindrical vessels 6³, 6⁴ constructed in a particular manner are provided, these vessels being traversed longitudinally by the primarily liquefied starch paste originating from the reaction vessel 4, the free cross-sectional area of said vessels being larger than that of the pipe conduits before and after the reaction vessel 4. The degradation reaction is terminated by the product being conducted through the inactivation device 18, to which steam is supplied from the pipe 19, and through the pipe conduit 20 serving as inactivation zone. The product thereafter flows through the throttle member 21 and through the expansion chamber 22.

The vessels 6³, 6⁴ serving for the continuation of the degradation reaction are so designed that their effective volume can be varied. Referring to Figure 3, the vessel 6³ contains a displacement member 23 which is arranged coaxially thereof and which consists of two sleeves 23¹ and 23² closed at one end, the said sleeves engaging telescopically one within the other at their open ends while sealing off their internal space from the free space of the vessel 6³. The sleeve 23¹ is secured by means of tubes 24 to the wall of the vessel 6³. On the other hand, the sleeve 23² is freely movable axially and is guided by a rod 25 extending through the bottom of the vessel 6³. It is thus possible for the volume of the displacement member 23 to be varied.

The primarily liquefied starch paste coming from the reaction vessel 4 passes through a pipe 26 into the vessel 6³ and leaves the latter through a pipe 27. The effective volume of the vessel 6³ can now be varied by altering the volume of the displacement member 23 for the purpose of adjusting the residence time of the starch paste in the vessel 6³. For this purpose, either the rod 25 is moved from outside in its axial direction, or a gaseous or liquid medium is introduced into or released from the interior of

continuously conveyed through the reaction vessel 4 where it is heated to 90°C. by mixing with steam, and subjected to high imposed stress by impacting and/or shearing forces. The gelatinisation and primary starch liquefaction produces a product with a viscosity of 350 cP. The starch product is conducted through the additional vessel 6² or 6⁴ having a capacity of about 100 litres and serving for continuing the degradation reaction and remains therein for 5 to 20 minutes, depending on the required degree of degradation of the starch. The counter-pressure built up by the reaction vessel and the necessary bend in the pipe conduit does not exceed 1 atm. gauge in this case. The sugar solution thereafter passes through the device 18, which serves for inactivating the enzyme, and is heated to at least 110°C for feeding in steam at a pressure of to 2 atm. gauge. The sugar solution remains for 30 seconds to 2 minutes in the subsequent pipe section 20 for complete enzyme inactivation. A sugar solution is formed which contains mainly limit dextrans and maltose and which can be processed to starch syrup by decolorisation, elimination of substances causing turbidity and concentration by evaporation.

WHAT WE CLAIM IS:—

1. A continuous process for the manufacture of starch decomposition products, particularly *d*-glucose or dextrin, which process comprises the steps of adding a chemically and/or biologically active substance to a starch suspension, passing the mixture continuously through a reaction vessel with temporary acceleration of the flow followed by direct mixing with steam, the added substance becoming active during and directly after the steam passage in a field of action of high imposed stress by impacting and/or shearing forces, and conducting the primarily liquefied starch paste thus obtained through at least one additional reaction vessel for the purpose of continuing the degradation reaction and adjusting required chemical or physical properties, the free cross-sectional area of the additional reaction vessel being larger than that of the pipe conduits before and after the first-mentioned reaction vessel.

2. A process according to claim 1 in which, after flowing through the additional reaction vessel, at least one additional chemically or biologically active substance is fed into the continuously flowing starch product.

3. A process according to claim 1 or claim 2, in which a temperature-sensitive carbohydrase is used as additional active substance.

4. A process according to claim 2 or claim 3 in which the flowing starch pro-

duct is cooled before the additional active substance is introduced.

5. A process according to any one of claims 2 to 4, in which the additional active substance is fed in as a solution or suspension in water for the purpose of cooling the flowing starch product.

6. A process according to any one of claims 2 to 5, in which the flowing starch decomposition product, after feeding in the additional active substance, is conveyed for the purpose of intensive mixing of the components through an arrangement in which the components, in the form of a film and with single or multiple deflection and acceleration, are exposed to impacting and/or shearing effects of high frequency.

7. A process according to any one of claims 2 to 6, in which the additional active substance is fed in between two vessels serving for the continuation of the degradation reaction.

8. A process according to claim 1 in which the starch decomposition product, for thermally inactivating the active substances, is mixed under super-atmospheric pressure with steam for the purpose of raising the product to a temperature above 110°C and is relieved of pressure after passing through a vessel for the completion of the inactivation.

9. A process according to claim 1, in which the reaction temperature in at least one of the reaction vessels is adjustable for regulating the properties of the end product.

10. A process according to claim 1, in which the quantity of added active substance is adjustable for regulating the properties of the end product.

11. An installation for effecting the process according to claim 1, comprising a first reaction vessel for the continuous primary liquefaction of starch as a result of the action of a chemically and/or biologically active substance, means for inactivating or destroying this active substance, and a second reaction vessel for continuation of the degradation reaction, said second reaction vessel being connected between said first reaction vessel and said means and having a free cross-sectional area which is larger than the pipe conduits before and after the said first reaction vessel.

12. An installation according to claim 11, in which the said second reaction vessel contains screens or sieves for making the flow uniform and for producing a mixing effect.

13. An installation according to claim 12, in which the free cross-sectional area of the individual apertures of the screen decreases from the inlet side to the outlet side of the vessel.

14. An installation according to claim 11,

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Fig.1

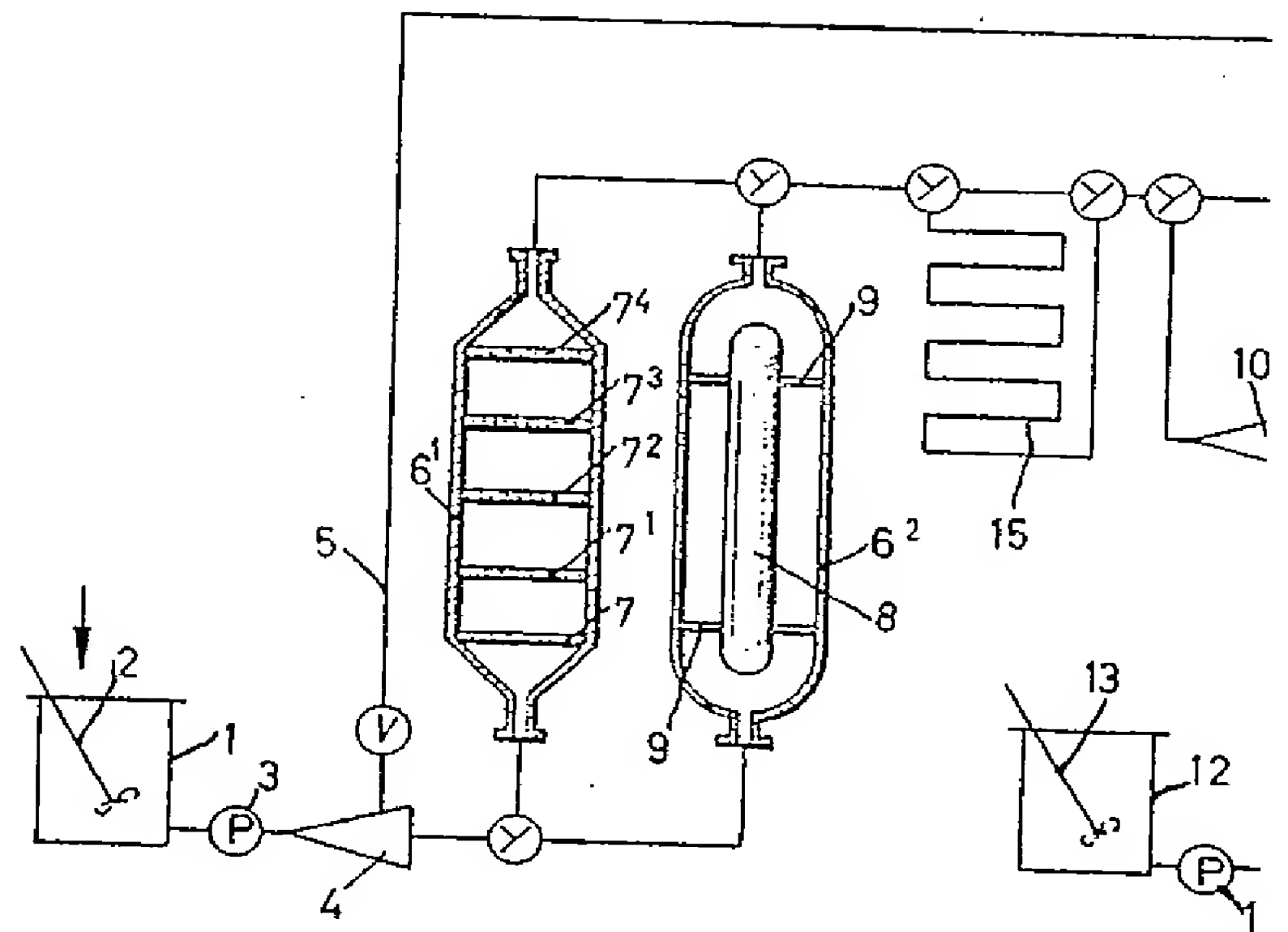
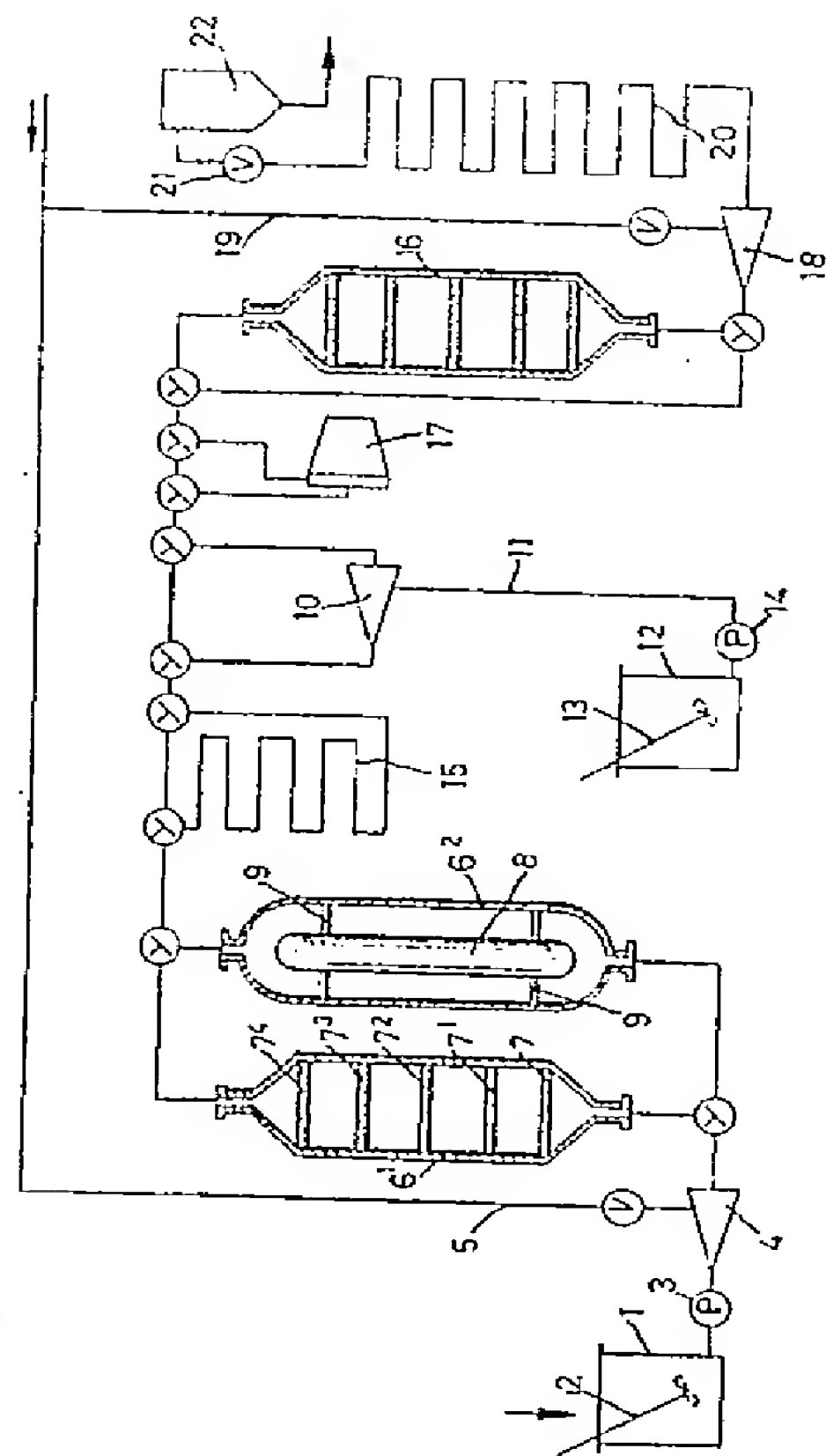
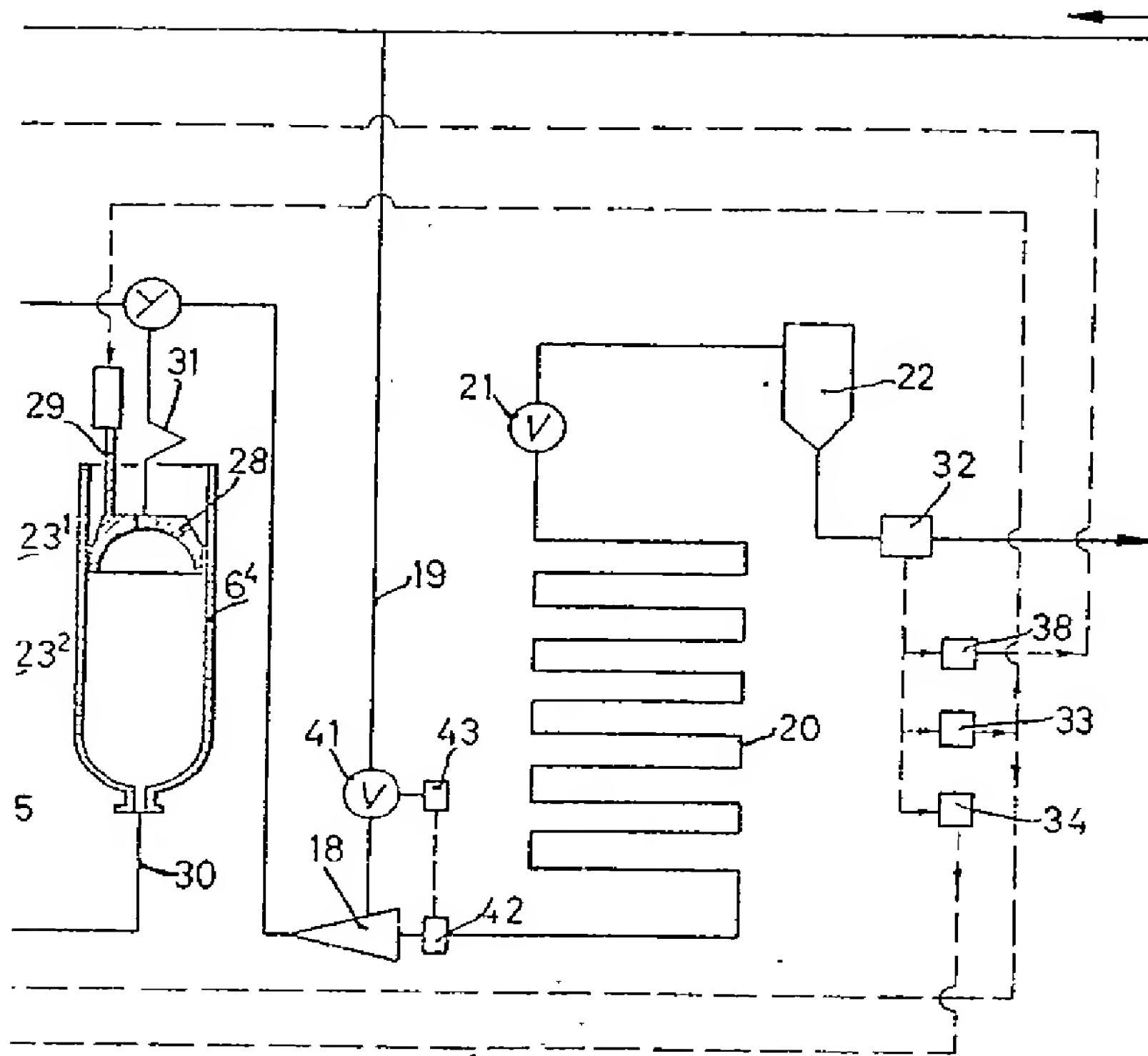
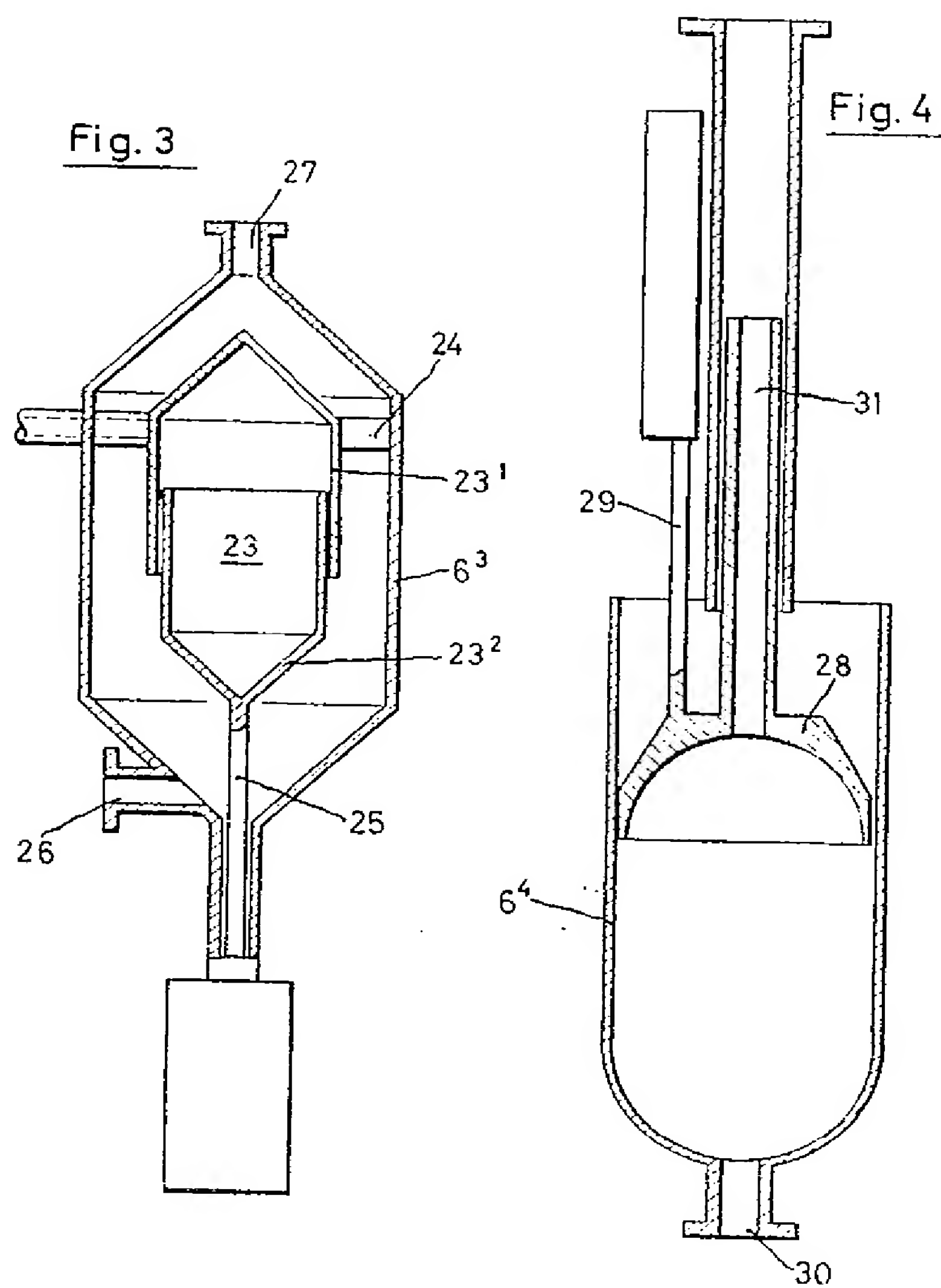


Fig.1







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COMPLETE SPECIFICATION DRAWINGS ATTACHED

Apparatus for the Continuous Gelatinisation of Starch and Starch Derivatives

We, ESCHER WYSS G.m.b.H., a German Body Corporate, of Ravensburg, Württemberg, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described, in and by the following statement.

This invention relates to apparatus for the continuous gelatinisation of starch.

Starch is an important basic material and auxiliary material for numerous branches of industry. It is used in the papermaking industry for sizing the paper in the pulp and on the surface, and as a binder for coating mixtures. It is also used in the textile industry for sizing and dressing, and is employed in numerous branches of the foodstuffs industry as a thickener. Still further, it is employed in the fermentation industry and in brewing for fermentation processes, and is used for the manufacture of dextrin, starch syrup and glucose. A prerequisite for the use of starch in the above-mentioned processes is complete gelatinisation. By the action of a temperature in the region of 65° to 70° C. and determined by the nature of the starch, the starch grains are caused to swell and are finally destroyed. The amylopectin and amylose molecules, which build up the starch grain, can hydrate and form a thick paste. The higher the concentration of this starch paste, the higher is also the viscosity of this paste, unless the amylopectin and/or amylose molecules have been exposed to a mechanical, chemical or enzymatic breakdown before or during gelatinisation.

Thermal gelatinisation of starch may also be replaced entirely or partly by alkaline gelatinisation. For this purpose, an ungelatinised or partly gelatinised starch suspension is mixed with an alkaline solution

of chemicals, preferably alkali lyes.

Starch paste can be made in tanks by a batch process. Either a starch suspension is raised to the gelatinising temperature by direct or indirect heating, or a starch suspension is poured into hot or heated water with stirring, or starch is sprinkled into hot or heated water with stirring. The disadvantages of these processes are that large tank installations are required for making the pastes, the installations require scrupulous attention, the starch gelatinisation in the batch process can only be inadequately adapted to sudden disturbances and changes in operation, the necessary uniformity of the pastes cannot be adequately ensured in every batch, and the starch pastes produced in a large quantity in each batch have to be kept during consumption for a long time at elevated temperatures, often in a temperature range which is advantageous for enzyme action, so that a reduction in yield and quality may ensue. In the manufacture of starch paste by the batch process, the workable starch concentration is limited to from 0 to 12%, unless pretreated, so that decomposed starches of relatively low specific viscosity are used. Attempts have often been made to obviate the difficulties in batch production of pastes by ordering for the required hot rolls or by means of some other process and using this so-called swelling starch. Transport of undried starch pastes between different works is accompanied by considerable risk, since as already mentioned starch pastes are exceptionally prone to enzymatic breakdown reactions. The transport of the amount of water contained in the starch pastes over considerable distances is in any event to be regarded as uneconomical. The use of swelling starch

[Pri

orifices for the steam, these orifices being in the form of passages 6 inclined to the tube axis in the direction of flow of the suspension. After the second constriction there are steam inlet orifices 7 in the tube wall as in the case of Figure 1, and after these orifices is a screen 8 which subdivides the suspension temporarily into a number of partial streams.

In the embodiment according to Figure 3, a diaphragm-like constriction 9 is followed by a gradual widening 10 of the tube cross-section. The steam inlet orifices are provided in the region of this widened portion 10 as passages 11 inclined to the tube axis in the direction of flow of the suspension.

In contrast to the arrangements shown in Figures 1 to 3, which have sudden cross-section constrictions, the apparatus according to Figure 4 has a slightly conical cross-section constriction 12, which may preferably also be of nozzle-like construction, followed by a gradual widening 13. In this case, the steam inlet orifices are in the form of passages 14 perpendicular to the tube axis. The widening 13 is followed by a second cross-section constriction in the form of a diaphragm 15, and the steam inlet orifices following this diaphragm are in the form of passages 16 inclined to the tube axis opposite to the direction of flow of the suspension.

Instead of individual holes or passages 5, 6, 7, 11, 14, 16 an annular gap or a series of annular gaps could possibly be provided.

In the apparatus described in Figures 1 to 4, clear functional relationships exist between the quantity and temperature of the starch suspension to be gelatinised, the starch content thereof and the nature of the starch, the quantity, the temperature and the initial pressure of the gelatinising reagent (heating steam or chemical solution), the free cross-sectional area for the passage of the starch suspension and of the gelatinising reagent, and also the velocities thereof. With constant free cross-sectional areas for the conveying and mixing of starch suspension and gelatinising reagent, the gelatinisable starch concentration is primarily determined by the admission pressure of the gelatinising reagent. With constant input pressure of the gelatinising reagent and a fixed free cross-sectional area for the passage thereof through the orifices in the tube wall, specific properties of the product (gelatinisation temperature, condition of swelling and disintegration of the starch) are only obtained with a specific, constant throughflow quantity of the product. However, if it should happen that, after a lowering of the production capacity, the flow velocity of the starch suspension through the constrict-

tion in cross-section and the subsequent tube section of the gelatinising apparatus falls below a predetermined ratio with respect to the input velocity of the gelatinising reagent with a constant input pressure, the components will not be uniformly mixed. If the flow velocity of the starch suspension increases after a rise in the processing capacity, a correspondingly larger amount of gelatinising reagent has to be introduced in order to maintain the desired properties of the starch product. With constant input pressure of the gelatinising reagent, the free throughflow area must be modified in order to ensure the necessary transfer of substance or heat.

The embodiments shown in Figures 5 to 8 of the drawings provide the possibility of adapting the apparatus to different working conditions by providing means which permit variations in the relative quantities, pressures and velocities of the suspension of the substance to be gelatinised and of the gelatinising reagent.

In all these constructional forms, the starch suspension to be gelatinised is conducted in the direction of the arrow through the tube 1. The said tube is enclosed by a jacket 2 which, in conjunction with the tube 1, defines the space 3 for the gelatinising reagent which is to be supplied, more especially steam or a solution of chemicals. The tube 1 has a conical constriction 17 in cross-section and a subsequent steady enlargement 18 for the cross-section, having inlet orifices 19 for the gelatinising reagent.

According to Figure 5, for varying the free cross-sectional area of the inlet orifices 19, a closed sleeve 20 serving as a covering member is arranged co-axially of the tube 1, the position of the tube being adapted to be changed in relation to the orifices 19. With axial displacement of the sleeve 20, the number of the free orifices 19 for the gelatinising reagent is modified. In order to render such a displacement possible, sleeve 20 is provided on its underside with a rack 21, with which meshes a gearwheel 22 adapted to be actuated from outside by means (not shown).

According to Figure 6, a sleeve 20ⁱ is provided as cover member, said sleeve comprising orifices 19ⁱ corresponding to the inlet orifices 19 for the gelatinising reagent. With displacement or rotation of the sleeve 20ⁱ, the free cross-sectional area of the individual inlet orifices 19, 19ⁱ is altered without the number of the free flow orifices being reduced or increased. The sleeve 20ⁱ can be externally actuated by a rod 23.

With the arrangement according to Figure 7, a displacement rod 24 is provided co-axially of the tube for the purpose of

pension of substance to be gelatinised.

8. Apparatus according to any one of Claims 1-5, in which the inlet orifices for the steam or chemical solution consist of passages which converge towards the tube axis in the direction of flow of the suspension of substance.
9. Apparatus according to any preceding claim, in which a screen for the temporary subdivision of the substance into a number of partial streams is provided in the direction of flow of the suspension of substance or paste after the inlet orifice or orifices for the steam or chemical solution.
10. Apparatus according to Claim 1, in which after the inlet orifice or orifices for the steam or chemical solution, there is provided at least a further constriction followed by orifices in the tube wall for the supply of cooling and diluting and/or preserving liquid.
11. Apparatus according to Claim 1 or Claim 10, in which after the inlet orifice or orifices for the steam or chemical solution, there is provided at least one further cross-section constriction with adjoining orifices in the tube wall for the return of already produced paste to a point of the apparatus situated upstream for the purpose of increasing the length of stay of the starch paste in the apparatus.
12. Apparatus according to any preceding claim, in which means are provided which enable the relative quantities, pressures and velocities of the suspension of substances to be gelatinised and of the gelatinising reagent to be altered.
13. Apparatus according to Claim 12, in which the free cross-sectional area of the inlet orifice or orifices for the gelatinising reagent is adapted to be altered.
14. Apparatus according to Claim 13, in which a cover member is provided, the position of which relatively to the inlet orifice or orifices is adapted to be altered.
15. Apparatus according to Claim 14, in which the cover member is formed as a closed sleeve which is arranged co-axially of the tube and which, by axial displacement, alters the number of the free orifices for the gelatinising reagent.
16. Apparatus according to Claim 14, in which the cover member consists of a sleeve which is arranged co-axially of the tube and which comprises orifices corresponding to the inlet orifices for the gelatinising reagent and alters the free cross-sectional area of the individual inlet orifices when it is displaced or rotated.
17. Apparatus according to Claim 14, in which control or regulating means are provided which alter the position of the cover member as a function of the gelatinisation temperature or the throughflow quantity of the starch product.
18. Apparatus according to Claim 12, in which the free cross-sectional area for the suspension in the transition range following the constriction in the cross-section of the tube is adapted to be altered.
19. Apparatus according to Claim 18 in which a displacement rod is arranged co-axially of the tube for altering the cross-sectional area.
20. Apparatus according to Claim 19, in which the displacement rod is displaceable axially.
21. Apparatus according to Claim 20, in which the displacement rod has a form which tapers towards the narrowest cross-section of the tube.
22. Apparatus according to Claim 20, in which the displacement rod is hollow for accommodating the gelatinising reagent and comprises outlet openings towards the flowing suspension.
23. Apparatus according to Claim 20, in which control or regulating means is provided which alter the position of the displacement rod as a function of the gelatinisation temperature or the throughflow quantity of the starch product.
24. Apparatus according to Claim 12, in which those surfaces which come into contact with the suspension and the paste are provided with irregularities.
25. Apparatus according to Claim 24, in which the irregularities consist of annular or helical recesses.
26. Apparatus according to Claim 24, in which the irregularities consist of individual protuberances.
27. Apparatus according to any preceding claim, in which it forms a component part of a paste-using machine or plant.
28. Apparatus for the continuous gelatinisation of starch, partly decomposed starch or starch derivatives by means of steam or a chemical solution, substantially as described with reference to any one of Figures 1-8, of the accompanying drawings.

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Fig.1

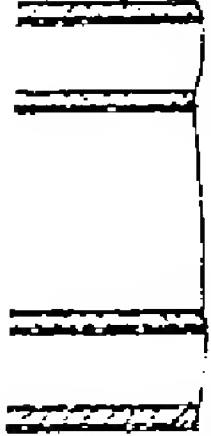


Fig.2

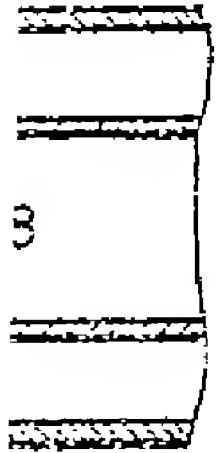


Fig.3

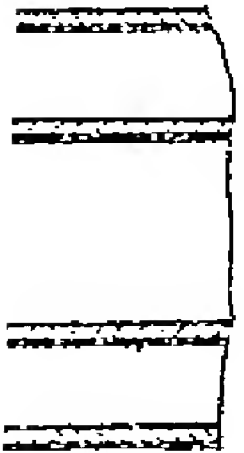


Fig.4

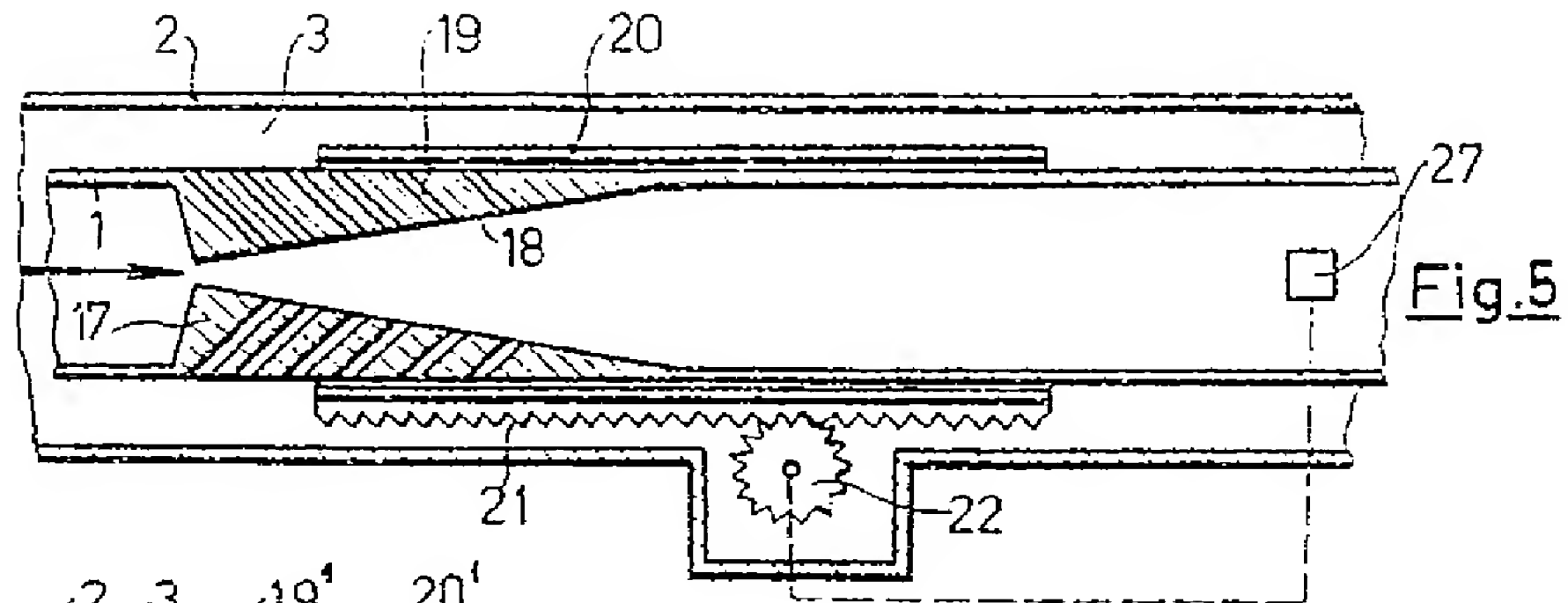
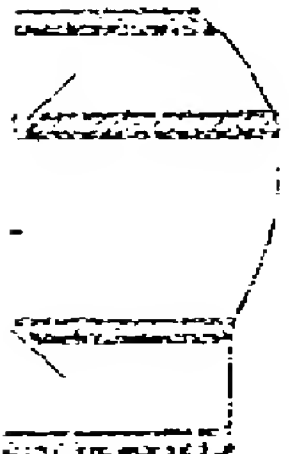


Fig.5

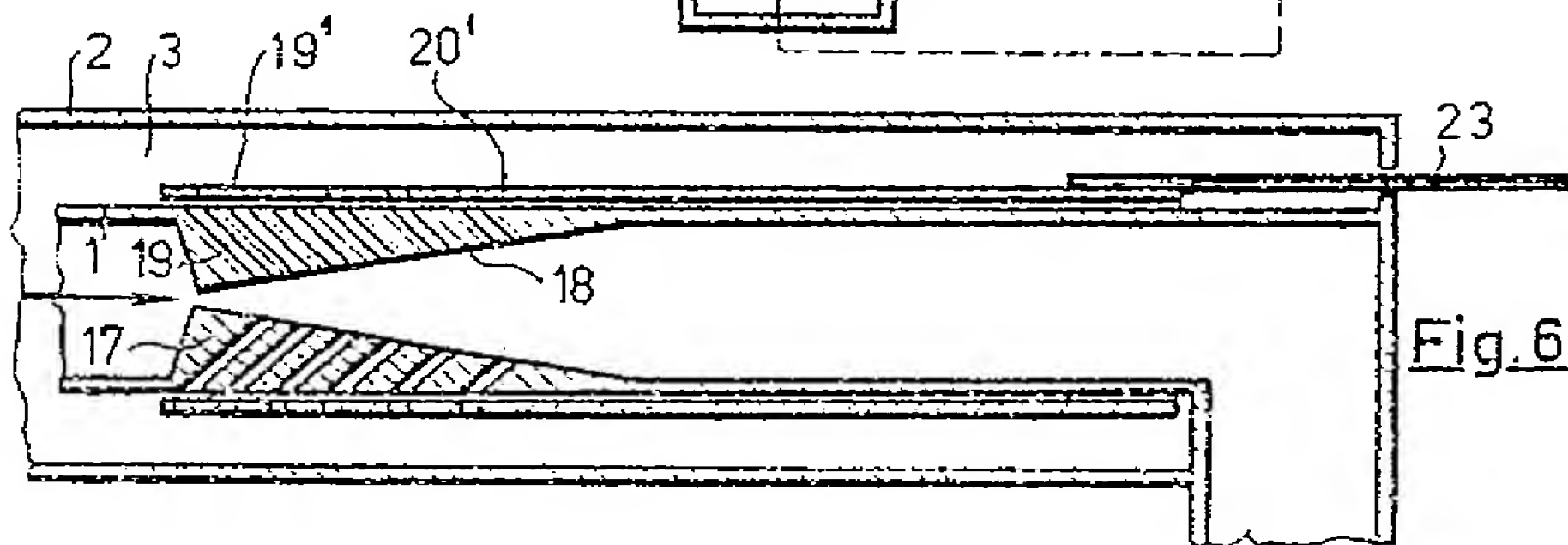


Fig.6

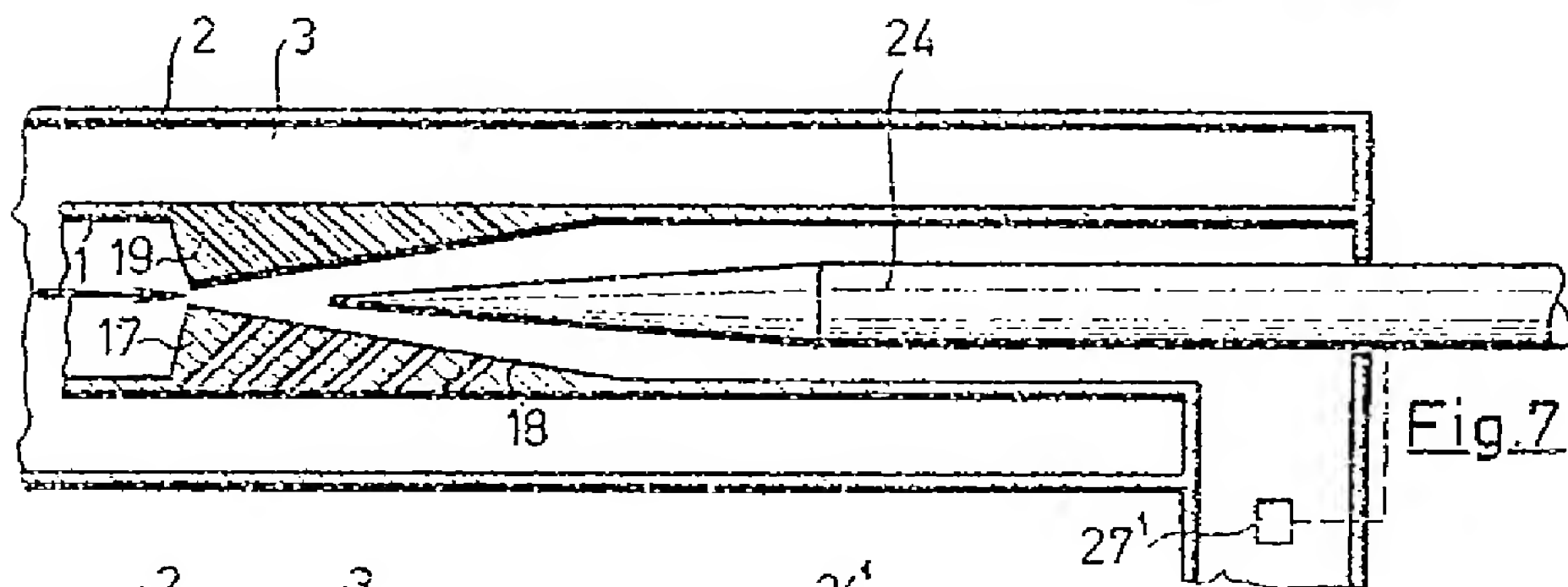


Fig.7

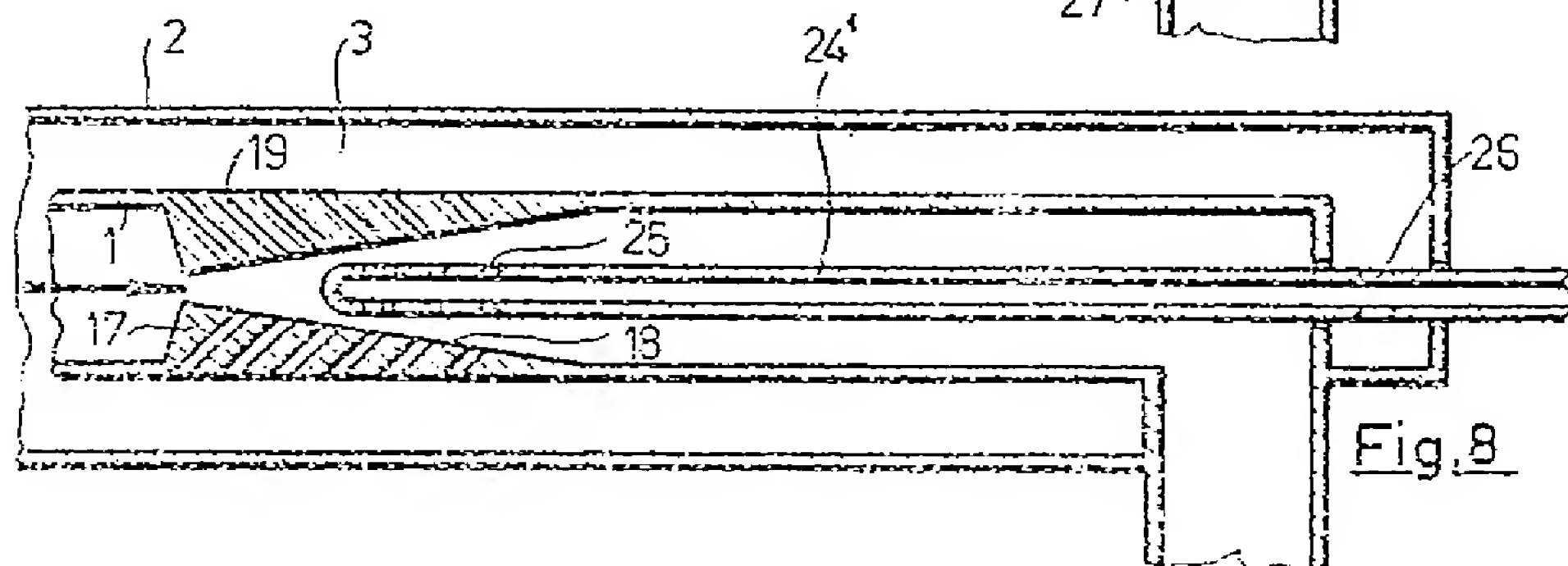


Fig.8